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PRESENT, FUTURE OF ENERGETICS DISCUSSED

Budapest ENERGIA ES ATOMTECHNIKA in Hungarian No 9, Sep 79 pp 386-394

[Article by P. S. Neporozhnyy, the Soviet Union's minister of energetics and electrification, corresponding member of the Soviet Union's Academy of Sciences: "The Present Situation and Future of Energetics"]

[Text] The need for long-range forecasting and planning of energetics (the supply of fuel and energy) closely coordinated with the growth of the national economy derives in part from the deep, long-range and ever-increasing effect society's total production exerts on the extent and directions of the development of energy management and electrification, and in part from the mutual effect the latter exert on the structure, growth rate and technological improvement of society's entire production. Much time is needed to optimize this complicated process. Working out the long-range prognoses and programs of energetics is important also because the cycle of testing out and implementing primary energy sources as well as transporting and transforming them and consumer equipment take a long time and require preparations begun at the proper time. Thus, looking far ahead exerts an effect on the structure of current measures, while the needs and tasks of the nearest time period also effect the end results. We understand energetics or the fuel-energetics complex to mean the totality (unity) of [all] processes and equipment connected with production, transportation, transformation, and use of all types of primary energy sources and secondary energy bearers. In this sense, energetics forms an all-encompassing system which in turn fits into another, still larger system--the national economy--and at the same time is composed of numerous mutually interrelated subsystems (coal, petroleum, natural gas, electrical energy) which to a significant extent substitute for each other. With its hydroenergetics branch, energetics is also connected to central water management.

1. Energetics and its Place in the National Economy

The growth ratio of energetics with respect to that of the entire economy is one of the most important ratios of the national economy. About one-third of the investments spent on developing the industry is spent on developing the fuel-energetics complex.

Our task is to produce and distribute the energy sources with minimal cost to society and with maximum efficiency for the consumers. In the course of this, the examination of the composition and location of the fuel-energetics sources, analysis of their production, transportation, transformation and use, as well as the extent and technological level of electrical energy management play important roles. Thus, all the things called methodical approach in science are fully implemented in our plans. The foundation for the main quantitative indexes of our energy-utilization programs is formed by balance calculations which also take into account the expected fuel sources, investments, etc. Demands in the areas of the various energy types, including the area of electrical energy, are examined by specific economic calculations: by comparing the various energy sources. In these comparisons, attention is paid to the production and transportation costs of electrical energy and other energy sources, as well as to what is the efficiency of their use by the consumers.

During the years of Soviet power we have created in our country a large and dynamically growing fuel-energetics complex which forms almost one-fifth of the world's total production of fuel-energetics sources, and in the last 15 years its growth rate has been 1.4 times that of the worldwide average. The Soviet Union is the only industrial power which is not only self-sufficient in heating material-energetics resources but also exports heating materials. In 1979 it will produce 593 million tons of petroleum (including condensed gases), 752 million tons of coal and 404 billion cubic meters of natural gas, and its electrical energy production will reach 1.265 trillion kWh. The Soviet Union occupies first place in the world in petroleum production and coal mining and second place in gas and electrical energy production.

Exploitation of the extensive Western Siberian petroleum and gas fields was prepared in good time in the Soviet Union, and in a short time the proportion of hydrocarbon heating materials increased significantly in the country's heating material balance.

The world's first atomic power plant was built in the Soviet Union (in 1954); since then numerous high-performance atomic power plants have been built, the machine industrial background was expanded and the foundations have been laid for further developing nuclear energetics. At the same time--in contrast with the capitalist countries which have committed the error of greatly reducing their coal industry--coal mining was consistently and steadily increased in our country and increased to 1.4 times in 1977 compared to 1960.

All the above factors formed the foundations of balanced growth of energy management and were a very important basic condition for the changes which are ahead of us in the structure of the fuel-energetics complex.

The following Table 1 characterizes the dimensions of absolute growth of our country's fuel-energetics complex.

Table 1. Growth of the Soviet Union's Energy Production

Years	1940	1960	1970	1974	1975	1976	1977
Produced quantity: energy sources, 10^6 tons ETA*	238.5	699.1	1,237.0	1,513.3	1,605.8	1,666	1,746
Electrical energy, 10^9 kWh	48.6	292.3	470.0	975.8	1,038	1,111	1,150
Petroleum (including condensed gases), 10^6tons	31.1	147.9	353.0	458.9	491	520	546
Gas, 10^9 cubic m.	3.0	45.3	197.9	260.6	289	321	346
Coal, 10^6tons	165.9	509.6	624.1	684.6	701	712	722
Hydroelectricity, 10^9 kWh	5.3	50.9	124.4	132.0	126.0	135.7	146

*Standard heating material (heating value, 7,000 kcal/kg)

The changes in the structure of primary energy sources produced can be seen in Table 2, which contains data about the ratios of the individual energy sources.

Table 2, Development of the Ratio of Some Primary Energy Sources in the Soviet Union.

Year	Petroleum	Gas	Coal	Peat	Hydroelectricity	Other
1940	18.6	1.9	59.0	5.7	0.3	14.5
1960	30.3	7.8	53.4	2.9	0.9	4.7
1970	40.6	18.9	35.0	1.4	1.2	2.9
1974	43.4	20.6	31.8	0.9	1.1	2.2
1975	43.6	21.6	30.4	1.2	1.0	2.2
1976	44.6	23.0	28.7	0.7	1.0	2.0
1977	44.6	23.5	27.8	0.8	1.1	2.2

Further improvement of fuel-energy structure has been planned in the resolutions passed by the 25th CPSU Congress by rationally combining the various fuel types and by decreeing that besides petroleum and gas, coal, shale, hydro- and nuclear energy must also be more widely used.

The significance of coal and nuclear energy are vigorously increasing mainly in the heating-material energy balances of the power plants. This growth direction insures further growth of the efficiency and operational reliability of the entire energy-supply system.

According to the 1976-1980 plan for developing the national economy, the total amount of energy sources to be produced in 1980 will exceed 2 billion tons of ETA. Of this, the share of petroleum production (expressed in terms of natural units) will be 640 million tons; natural gas, 435 billion cubic meters; coal, 805 million tons; hydroelectricity, 25 million tons of ETZ.

3. Energy Supply -- Energy Systems and Their Unification

Qualitative improvement of the fuel-energetics complex is progressing in the direction of concentrating the energy industry, as this is a very important condition for decreasing the costs per unit of energy. Besides rapidly improving the general transportation of energy sources (by rail and water), but especially the specialized transportation forms (pipelines and electrical energy), this has created the conditions for transmission of electrical energy from the centralized fuel and energy sources to grow to several times that of the level in the past.

Huge energetics systems have developed such as electrical energy, the petroleum and gas supply systems, and the nuclear energetics system is now being developed. Currently, the electrical-energy-supply systems provide 97 percent of all electrical energy used, and the Unified Gas Supply System supplies 90 percent of the gas consumers; 70 percent of the heat consumers are supplied by centralized heat-supply establishments; supplying the consumers with petroleum products is fully centralized and to a significant extent so is their supply with coal.

The ratios between the fuel-energetics complex and the national economy's growth are characterized by the data in Table 3.

Table 3. Development of the Indexes of National Economy and the Heating-Fuel and Energetics Complex. (1940 = 100)

	1940	1960	1970	1974	1975
Growth index:					
Electrical energetics	100	678	1,800	2,500	2,600
Fuel industry	100	353	636	795	846
National income	100	435	867	1,092	1,142
Gross industrial production	100	521	1,183	1,575	1,694
Labor's productivity in industry	100	296	492	621	657
Electrification of processes in industry	100	300	525	637	675
Mechanization of processes in industry	100	230	520	640	660
Mechanization of agricultural activity	100	360	750	1,020	1,130

Thus from 1940 to 1975, production of the electrical-energy branch of the industry increased 26-fold, together with an 8.5-fold growth of the heating-fuel branches and a 17-fold increase in the volume of industrial production. At the same time, the national income increased 11.1-fold. Each percent of growth in the national income was accompanied by a 0.76-percent growth in fuel and 2.3-percent growth in electrical energy.

As it also appears from the above, in our country electrical energetics in particular increased at a rapid rate. As early as at the dawn of Soviet power, V. I. Lenin, our country's founder justified by his words that deep-rooted, definitive interrelationship which exists between electrification, technological progress and the growth of society's production.

The huge electrical-energy basis created by the work of the Soviet people made it possible to thoroughly transform the national economy on the basis of leading modern technology, so that we are able to elevate our country's whole industry onto a new quality level. We built several thousand modern large enterprises in which the mechanization and automation of production processes is high. Today agriculture uses as much electrical energy as the entire country consumed in 1950; in 1985, agriculture's electrical-energy consumption will increase to between 170 and 190 billion kWh.

Naturally, electrical energetics itself is also developing on the basis of the most modern technological solutions which are characteristic for each and every stage of its development. With respect to numerous technological directions, such as the areas of concentrating the performances in thermal and hydroelectric power plants, developing remote heating, the voltage level of high-tension long-distance power-transmission lines used, and the capacity of energetics associations, the Soviet Union is among the world leaders.

At the end of 1977, the built-up performance capacity of power plants was about 240,000 MW, and electrical-energy production was 1.15 trillion kWh.

As a result of the planned 1978 start-ups, the built-up total output capacity of all the Soviet Union's power plants almost reached 250,000 MW, among them that of turbine-powered power plants, 182,600 MW (73.1 percent); nuclear power plants, 10,100 MW (4 percent); hydroelectric power plants, 48,200 MW (9.3 percent), and nonturbine driven power plants 8,900 MW (3.6 percent).

The unified energy system whose built-in power plant performance capacity exceeds 160,000 MW was created. This unification made significant savings possible, increased the operational reliability of supplying the national economy with electrical energy, created the opportunity for flexibility depending upon performance and availability of fuel energy supplies. Long-distance electrical transmission lines cover our country's entire inhabited area with their network, their length being more than 4 million km. This made it possible to electrify all cities and villages, state farms and cooperative farms. The Soviet Union's unified energy system has advanced

connections with the unified energy systems of the CEMA countries at 400 and 220 kV tensions; the 750 kV intersystem long-distance transmission line between the Soviet Union and Hungary has been started up.

The overwhelming majority of energy produced by thermal power plants is produced by huge power plants of 3,600 to 4,800 MW output capacities. The number of thermal power plants with 1,000 MW and larger output capacity was 40.

In thermoenergetics the introduction and mass application of supercritical steam parameters was an important facet of technological growth during the Ninth Five-Year Plan (1971 to 1975), significantly increasing the economy of energy production. At the end of 1977, there were in our thermal power plants 149 blocks operating with supercritical parameters and 300 MW or greater output capacity.

During the Tenth Five-Year Plan the decisive portion of output capability increase must for the most part be accomplished with the start-up power plant block units with 500 and 800 MW output capacity.

This five-year plan will be the initial time period for the 1,200 MW blocks. By 1980, electrical-energy production will grow to 1.34 trillion kWh, through the appropriate growth of built-in power plant output capacity. Besides the thermal power plants intended for basic-load operation and built with equipment with high-output capacity and with supercritical parameters, there are in the Soviet Union in the development stage special production equipment with high maneuvering capabilities, the unit-output capacity of the machine units of which will be 500 MW and will serve to operate in the fluctuating load section (semipeak zone) of the electrical-load diagrams.

Gas turbines and combined steam-gas equipment with high output capacity will be installed in our country's power plants to cover the sharp peaks of the production schedule.

In spite of the fact that we have significant amounts of energy sources, we consider it necessary to use them as rationally as possible. In this respect remote heating is one of the main measures, that is, the development of joint production of electrical and thermal energy. In this area of energetics, the results achieved in the Soviet Union have become examples for numerous countries. Heat supply by power plants is a high-efficiency measure which makes fuel savings of about 25 percent possible in comparison with producing electrical and thermal energy separately, at the same time making it possible to eliminate polluting the air of cities and other inhabited areas by smoke and soot from small heating plants. Heating power plants now meet about one-third of our country's electrical energy needs and about 40 percent of its thermal needs, 800 cities use the heat produced in high-output-capacity heating power plants.

In the Soviet Union in recent years we have implemented the serialized production of huge heating turbines with 100, 135 and 250 MW unit output capacities, and the unit output capactiy of heating power plants has reached 1,250 MW.

The total built-in output capacity of long-distance heating machine units makes up about 30 percent of the output capacity of thermal power plants. For the years of the Tenth Five-Year Plan, we have planned further development of long-distance heating. At the same time it must be mentioned that the specific costs of built-in output capacity per kW in heating power plants are higher than the per kW costs in condensation thermal power plants. Those heating power plants which are built in inhabited areas use quality fuels due to ecological considerations. Therefore the growth rate of heating power plants in our country is determined on the basis of careful economic calculations, comparing it with the alternative of separate power supplies (with electrical energy from the energy system, heating energy from the large district heating plant).

Considering the fact that thermal energetics is growing rapidly all over the world, as is well known, in recent years the problem of environmental protection has come up particularly sharply. Much has already been done in the Soviet Union to decrease pollution of the environment, in the interest of eliminating harmful effluents, to decrease the areas occupied by power plants. We have taken definitive steps in the interest of building 99-percent efficient, very effective soot-filtering equipment into power plants, work is being conducted on a broad front to separate sulphur dioxide and nitrogen oxides.

The Soviet Union is the pioneer in the peaceful use of nuclear energy. The growth of nuclear energetics in our country can in part be explained by the fact that organic fuel is very expensive in the European part of our country, and in part by the advantages of nuclear power plants. With respect to technical and economic indexes they are already competitive with coal-fired thermal power plants. Besides this, nuclear power plants cause much less pollution in the environment than thermal power plants. At present, our country has 440 reactors with 1,000 MW_e unit output capacity, which are operating or are being built in numerous nuclear power plants.

Several types of energetics reactors are used in the Soviet nuclear power plants. The most popular types are the water reservoir-watered reactors and the "csatornus"-graphite [?] reactors [channeled-graphite?]. A 1,000 MW capacity VVER-type reactor operates in the Novovoronyezh nuclear power plant.

Output capacity of the channeled uranium-graphite type RBMK reactors is 1,000 MW. When these reactors were developed, the construction and operating experience gathered at the water-graphite reactors built in the Byeloyarsk Nuclear Power Plant were taken into consideration. This type of reactor is operating in the Leningrad and Kursk nuclear power plants, and is under construction in the Chernobilsk and Smolensk nuclear power plants.

Construction of the Ignalinsk nuclear power plant with a 1,500 MW capacity reactor will begin in 1980. On the basis of this reactor type now 2,400 MW unit capacity reactors are being prepared. All this makes it possible for us to build nuclear power plants with capacities extending up to 10,000 MW. We will use nuclear energy to supply heat in the nearest future (ATEC, ASZT).

Introduction of the fast-neutron reactors which will make it possible to use U-238 which occurs in nature in the overwhelming majority of the ratio, will mean a new era in the growth of nuclear energetics. The first fast-neutron industrial reactor with 150 MW electrical output capacity has been operating in our country since 1973 in the Shevchenskovsk nuclear power plant. The third block equipped with fast-neutron reactors, the unit output capacities of which are 6,000 MW, are now under construction in the Byeloyarsk nuclear power plant. Development and industrial-scale installation of such type reactors with high output capacities already has great significance from the viewpoint of the growth of nuclear energetics in the foreseeable future.

In the Soviet Union, the growth rate of nuclear energetics and geographic location of nuclear power plants are determined by technical-economic considerations. As is well known, 90 percent of our fuel energetics supplies are located in the eastern areas of the country, this is why these areas have become the main producing areas for primary energy sources.

At the same time, the difference between fuel prices is also very significant between the eastern and western areas, and in extreme cases even reach five- to seven-fold. Calculations showed that under such circumstances the development of nuclear energy is efficient in the Soviet Union's European area where the cost of organic fuel is high. Development of nuclear power plants is not expeditious from the economic viewpoint in the Siberian and Central Asian areas which have huge coal and natural gas inventories. Therefore all large nuclear power plants are built in the European part of the country's unified energy system.

The following large nuclear power plants are being built on the Soviet Union's European area: Kursk, Chernobilsk, Smolensk, Yuzhno-Ukrainsk, Kalinyinsk, Rovensk, etc.

As a consequence of the economy of nuclear power plants, there are no new condensation-power plants with basic loading being planned to be built for organic fuels in the Soviet Union's European part. At the same time, the concrete development rate of nuclear energetics in the sections of the country's European part are also determined with attention to the operating mode requirements of the energy systems. Currently, due to their technical characteristics the nuclear power plants cover the basic load demands of the load schedules of energy systems. This circumstance will cause difficulties in the energy systems in the time periods of load decreases at night when the output capacity of nuclear power plants will be large. Special regulating consumers will have to be created which are suitable to use up the energy produced in the valley time periods. Pump-operated

storage power plants, which in this period of the day operate in the pump-mode will have to be such consumers, as will air-storing turbines, at times the heat-storing systems of the heat supply, etc. In the opposite case, a quite significant regulatory range should be planned for nuclear power plants. There are also suggestions for developing special semipeak nuclear power plants which would be scheduled between the new nuclear power plants now being started up.

The question of increasing the flexibility of the nuclear powerplant network comes up even more sharply due to the fact that over the longer range when the large number of fast-neutron reactors will be started up, the latter will be placed into the basic-load zone, "forcing out" the thermal-neutron nuclear power plants in part into the semipeak zone.

In time, the effect of nuclear energetics will become decisive from the viewpoint of developing the structure of energy systems in the country's European section as well as with respect to the entire fuel-energetics balance. We must also keep it in mind that in a certain stage of development in this part of the country the economic indexes of nuclear energetics will probably become definitive with respect to the resulting costs.

This complicated question must be studied separately and carefully because its successful solution will have a great effect on the results of technological and economic calculations, among other things, in selecting the structure of central heat supply (proportions between heating power plants and separate energy supplying schemes).

Almost 12 percent of all the world's hydroenergy inventory is in the Soviet Union's territory. Exploitation of the most efficient hydroenergy sources, that is, of the economical hydroenergy potential is at the present time about 13 percent in our country, but as high as about 35 percent in the Soviet Union's European section. The built-in output capacity of hydroenergy power plants in 1978 was more than 19 percent of the total built-in capacity, and their share exceeds 14 percent in the production of electrical energy. In several economic regions and federal republics (the region along the Volga River, Armenia, Gruzia, Tadzhikistan, Eastern Siberia) this index reached 25 to 50 percent.

With respect to the complicated nature and dimensions of the tasks to be solved in the area of hydroenergetics, the Soviet Union is among the leaders of the other highly advanced countries. With respect to the unit output capacity of hydropower plants and the concentration of hydroenergetics output capacities, the Soviet Union occupies first place in the world.

The foundations of Soviet hydroenergetics are formed by 60 hydropower plants, each with an output capacity of 100 MW or more, the total output capacity of which exceeds 90 percent of the country's total built-in hydropower plant output capacity.

About 60 percent of the total hydropower plant output capacity is concentrated in 11 hydropower plants each with a capacity of 1,000 MW or more. The largest hydropower plant in the Soviet Union and in the world is the 6,000 MW (12 blocks, each 500 MW) output capacity Krasnoyarsk Hydropower Plant. The 6,400 MW Sayano-Shushensk hydropower plant being built on the Yenisei River will be even larger than this; 640 MW unit capacity Francis turbines will be installed in it.

Depending on regional conditions, the development of the Soviet Union's hydroenergetics is progressing in three directions.

The first direction is characteristic mostly for the central districts and for the Ural area, where, as a consequence of the constant increase in the unevenness of electrical-load schedules and of the growth of the unit output capacities of power plant blocks, the role of regulating the load of energy systems is being placed increasingly on the hydropower plants: the hydropower plants in these regions serve primarily to operate in the most fluctuating parts of the load schedules, thus increasing the stability of the energy systems. About 40 percent of the reserve output capacities of the unifications is concentrated in the hydropower plants. Besides building the "peak" hydropower plants in the Soviet Union's central, southern and northeastern districts, the new, effective direction of energetics, water storage is also growing. Thus, among other things, the Soviet Union's first 225 MW output capacity pump-storage power plant is under construction near Moscow, construction will begin very soon on a 1,600 MW output capacity pump-storage power plant on the coast of the Baltic Sea, after that will begin construction on a huge pump-storage power plant in the Ukraine.

The other development direction of the Soviet Union's hydroenergetics is characteristic for the eastern regions of the Russian Soviet Federal Socialist, first of all for Siberia. The electrical energy produced here in the large hydroelectric power plants is used to further increase the economic potential of the regions, to create energy-demanding, huge national economic complexes. Construction of every single large hydropower plant in the Soviet Union's eastern region is essentially equivalent to conquering a huge new area economically, creating modern production and living conditions for the work of several tens of thousands of people.

The third very important direction which promotes the increase of efficiency of hydroenergetics is the comprehensive exploitation of hydroenergetics resources. This direction promotes conquering the country's new regions which have a great future so that we can develop broad areas of irrigating the land, waterway transportation and supplying industry and the population with water. Comprehensive utilization of water resources is characteristic for all water-related construction districts of the Soviet Union, but it is particularly important in the water-poor regions, primarily in Central Asia. The largest waterway locks complexes under construction here are the one at Nureksk (about 1 million ha of land can be irrigated from its water storage), one at Toktogulsk (1.1 million hectares), Tuyamuyunsk on the Amu-Darya River (500,000 ha), Chirkeysk (210,000 ha). The hydropower plants operating

Northwestern districts. The complex interlocking 750 kV long-distance transmission line system will have to be completed in the next 10 to 12 years, keeping in mind that these long-distance transmission lines would be practical to build where the main, larger-capacity nuclear power plants are being built. This ring, whose full length will be over 7,000 km, will include the already built long-distance transmission lines and will run on the Leningrad-Central-East Ukraine-West Urkaine-Byelorussia-Baltic region-Leningrad path.

In order to meet the constantly increasing demands made on the transmitting capabilities of the system-forming and intersystem connections we are also establishing the new, superhigh-voltage 1,150 kV AS voltage.

There is already successfully operating in the Soviet Union an 800 kV voltage DC long-distance transmission line between Volgograd and the Don Valley. The operating experience gained in this long-distance transmission line will serve to prepare establishment of the 1,500 kV 2,500 km DC transmission line between Kazakhstan and the Central region; its transmitting capacity will be 6,000 MW and it will transmit the inexpensive energy of power plants using coals from Ekibastuz into the central district of the country's European segment. Even higher DC voltage (2,200 to 2,500 kV) will be necessary for the mass transmission of electrical energy from the power plants of Siberia.

Construction of the uniquely high voltage 2,500 kV, 40,000 MW transmitting capacity binary-system DC transmission line would be a great solution to transport the energy reserves of the Kansk-Achinsk coalfields to the Soviet Union's European regions. One single such transmission line would make it possible to transmit an energy quantity equivalent to 160 million tons of Kansk-Achinsk coal.

The new energy sources and power plant types, namely nuclear power plants, will have an interesting effect on the structure of long-distance energetics systems. The analysis does not prove the opinion and statement of some of the foreign exports that development of nuclear power plants can lead to the "atrophy" of the energy systems and long-distance transmission lines, etc, since those can be brought very close to the consumers. In such opinions, it is being forgotten that it is a precondition for the economic advantages of central electrical energy supply (output savings, optimum utilization of all power plant types, increasing operating reliability and stabilization of the energy supply, use of the most economical energy sources, etc) that huge output and energy flows be formed with either permanent or periodically changing character. The possibility of bringing the nuclear power plants close to the large consumer centers does not theoretically alter this fact. In addition to this, numerous technical and economic factors become very efficient by starting out from the very possibility of increasing nuclear power plant capacities and creating nuclear power plant associations, since these can create hugh energetics flows, causing in turn the growth of electrical networks. With other conditions being unchanged, increasing the energetics load densities of the European districts will decrease the transmission distance from the

and under construction with water storage facilities make irrigation possible on more than 10 million ha of land and in addition to this they also provide auxiliary water supply for 17 million ha. In addition they make flood protection possible for over 500,000 ha.

It is a ypical characteristic of the Soviet hydroenergetics system that hydropower plant chains (cascades) are built on rivers. This provides the opportunity for increasing greatly the degree of control over the water's flow, increase the output capacities of hydropower plants as well as their production, and implement reconstruction of waterway transportation.

One of the most important factors of our country's efficient energetics development is the constantly increasing centralization of electrical-energy production and distribution. There are 94 energy systems operating in the Soviet Union, which are grouped into 11 huge energetics associations, and are as follows: Northwestern, Central, Central-Volga, Southern, Northern Kazakhstan, Trans-Caucasian, Ural, South Kazakhstan, Central Asian, Siberian, Far Eastern (the latter is now being formed).

Of these, eight already belong to the country's Unified Energy System, the networks of which cover 6.5 million square Km inhabited by 200 million people. The total built-in output capacity of power plants which belong to the Unified Energy System, as we have already mentioned above also, surpassed 160,000 MW.

The total length of 35 kV and higher-tension long-distance transmission lines is more than 600,000 km, and the length of 0.4 to 3.5 kV-tension regional long-distance power lines surpassed 3.4 million km. Long-distance power lines within the systems and between systems, automated breakdown-protection equipment and reserves guarantee the certainty of electrical-energy supply. Broad ability to maneuver with energy currents is even now also making significant electrical performance savings possible. Considering the fact that in the east-west direction the Unified Electrical Energy System has been completed over very significant distances, the time differences between certain areas of the country can be taken advantage of in broad areas. Together, the system's power plants satisfy the maximum loads of the Northern Kazakhstan, Ural, Volga Region and Central District which appear with a shift in time. Combining the maximum loads, which is also accompanied by a decrease in the necessary operating interruption reserves, even now represents a savings of at least 5,000 MW output. After the Siberian and Central Asian districts are connected to the unified energy system, over the long range the output savings may increase to 20,000 to 30,000 MW.

In the development of energy systems, technical development is accompanied by the application of constantly increasing voltages, for alternating as well as for direct currents. The 750 kV networks are widely expanding in our country. The 750 kV Donbass-Lvov long-distance transmission line in the Trans-Ukraine has been started up, and will be extended to strengthen the connection with the unified energy systems of the CEMA countries. A similar long-distance transmission line connected the Central and the

individual generating facilities. Therefore, it can be one of the alternatives of the unified energy systems's structure that electrical energy distribution can be implemented in districts containing large production capacities, in radial directions at 500 to 750 kV voltages even over relatively short distances, with 220 to 530 kV branch-offs. These systems are interconnected with a 750 to 1,150 kV AC network in the interest of intersystem efficiency. The huge, 150 to 250 MW capacity associations created in this manner can become separate sections of the country's unified electrical energy system. These sections can be connected with each other with DC lines.

The very-long-distance connections are superimposed on the intersystem network. These--as we have already mentioned above--will be implemented in the form of 1,500, 2,200 and perhaps 2,500 kV DC long-distance transmission lines. Finally, the possibility is also not excluded that later theoretically new, efficient electrical-energy transmission methods will appear on the scene, the gas-filled cryogenic and other transmission types.

4. Prospects For the Energy Systems

Foundations of the country's future unified energy supply system are now in the process of being formed: this would combine the country's electrical, gas and coal supply systems in one common system.

These systems will be connected with each other primarily by the central management of joint operating modes, with underground gas-storage facilities, buffer regulators and storage facilities, and also with the cooperation of transportation equipment. All these must already be coordinated in the planning stage when in essence the directions and parameters of pipelines, long-distance transmission lines and railroad transportation cannot be selected without comprehensive evaluation of the transportation system of the country's energy supply as an integral unit.

In the next 20 to 30 years with electrification in the lead, the energetics complex will occupy a special place among the other production complexes which make up the branch structure and most advanced technological structure of new production. Significance of the fuel-energetics branch and of electrification will also increase in solving the tasks related to regional organization of the production forces.

Growth of the dimensions of society's production and thorough development of its technological, branch and regional structures will determine the rapid rate of demand's growth which will appear in the areas of all types of energy sources but particularly of the electrical energy.

This task, which is dictated by the objective requirements of developing the national economy, can be solved only if we implement deep-rooted changes in the regional structure of the fuel-energetics complex itself. The goal of the above-mentioned development is to insure the use of the country's

energetics resources in optimum combination and such extent of development of the material and labor investments which is appropriate for the fundamental ratios of developing the entire national economy.

Studies have shown that in order to satisfy the advance consumption estimates of electrical energy and of fuel-energetics sources, it will be necessary to significantly develop nuclear energetics as one of the most important branches of the country's fuel-energetics and electrical energetics management, primarily in the Soviet Union's European regions; natural gas and petroleum production must be increased, constantly increasing amounts of coal--mainly from open pit mining--and hydroenergy must be used.

Under the conditions of the expected large-scale growth of the national economy's energy needs, these changes are triggered by the goal that all energy types must be assigned to the consumer category which can use it with the highest degree of efficiency. Nor can the world market situation be left out of the considerations, because since 1973 the price of petroleum has increased more than fourfold. Under such conditions, petroleum as the primary energy source must be assigned primarily to the technological consumers and for transportation, and its use as furnace and heating fuel must be decreased to a minimum.

Thus, the ratio of white products must increase in the structure of petroleum processing and that of residual oils must decrease. In the boiler-furnace fuel balance, natural gas, coal and nuclear energy are to replace petroleum.

These changes in the ratios of primary energy sources will be followed by shifts in the structure of secondary energy sources, primarily in the direction of increasing the share of electrical energy. Such changes--increasing the depth of electrification of the national economy--are the consequences not only of the fact that electrical energy and electrification have great significance for the technological development but they also increase the productivity of labor. These also reflect the growing and, in our opinion, decisive role of electrification on the resource side of the fuel-energetics equation. Such primary energy sources as poor-quality coal, the hydroenergy sources of the country's eastern regions and nuclear energy can be included in the country's energy balance only by relaying them through power plants which produce electrical and thermal energy.

On the other hand, electrical energy produced by nuclear fuel and poor-quality coal forces out the excellent-quality fuel from production technologies. This creates the basic conditions for us to rise to a theoretically new level in the area of supplying energy for work and for production, opening up new opportunities to accelerate the increase in labor productivity.

Decreasing the costs of producting electrical energy will open up great opportunities for new technologies such as for plasma, quantum, chemical

and radiation, magnetic, etc, technologies. Great productivity is not the only characteristic of these technologies requiring very large amounts of electrical energy, but also that they can be used to create waste-free processes, thus decreasing the national economy's need for materials which is based on the consumption and processing of excellent-quality materials. Developing waste-free technologies and decreasing the demand for materials will at the same time also represent huge environmental-protection factors.

5. Long Range Development of Energetics

In light of the foregoing, obviously the vistas ahead of us can be divided into two stages, the first stage, speaking of it completely conditionally, can be estimated for the end of our century.* This era is characterized by nonrenewable energy sources (petroleum, gas, coal, uranium).

However, over the longer historical range this stage is only the first step in the era of development which encompasses several decades, the characteristics of which will be that it will gradually be transformed from energetics based on the limited, nonrenewable organic fuel resources which are becoming more and more expensive to energetics which use primarily the unlimited energy sources of the atomic nucleus. Currently we do not have sufficient information to form a sufficiently believable model concerning the structure and economic parameters of the energetics of the above-mentioned remote era. In spite of this it can be assumed with a great degree of probability that this will be characterized by the energy of fast neutrons, nuclear fusion, broad-based use of solar and geothermal energy. In the interest of waterways management and energetics purposes, the country's water resources will undergo large-scale geographic regroupings in this time period.** Taking into consideration the time requirements of the huge new energetics programs for engineering work, obviously this will already have to be started in the time period before the year 2000.

Under these circumstances, it has great significance for laying the foundations of the significant economic growth ahead of us to prepare in good time the significant economic growth ahead of us to prepare in good time the mining of traditional energy sources (coal, petroleum, natural gas, uranium) which will have to serve as foundations for the national economy's energy supply until the year 2000, at the same time insuring a smooth transition into the following stage.

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* Its limits may get postponed by one or two five-year plans.

** We have already made an attempt to determine the proportions of the resources of the distant future with respect to electrical energetics in our study entitled "Electrification of the Soviet Union," ENERGIA 1970 p 87.

The thorough structural changes ahead of us in the fuel-energetics complex will be followed by large geographic shifts in producing energy sources and in certain branches of the energy industry.

Based on the distribution of our coal resources, but mainly on their economic characteristics, exploitation of fuel-energetics resources will be escalated mainly by increasing the capacities of the coal, petroleum and gas industry in the country's eastern regions, during the course of which the share of the eastern regions will unavoidably increase in the total production of fuel-energetics resources. Thus, for example, petroleum production in western Siberia will exceed 300 million tons as early as at the end of the Tenth Five-Year Plan, and the bulk of the gas-production increment will also come from western Siberia. There will be huge tasks in the areas of opening up and making use of the Kansk-Achinsk, Kuznyets, Ekibastuz and other coalfields.

Such deep-rooted changes taking place in the geographic proportions of fuel production, which will basically remain in the areas of energy utilization, will not only pose huge tasks for the national economy in connection with creating new, large fuel bases in the country's relatively poorly developed eastern regions but will also bring forth an independent problem, that is, the problem of organizing the long-distance mass transportation of fuel and energy into the country's energy-poor regions.

The analysis has shown that the problem cannot be solved by some one single type of transportation method because both railroads and pipeline transportation will have to be involved, as will the new superhigh-tension and superhigh-transmission capacity long-distance transmission lines (namely, the 2,500 kV DC long-distance lines).

One of the most efficient channels for including the resources of the eastern regions into efficient utilization is to locate the high energy-demanding industries in these areas, transporting part of their products to the western regions, thus transforming energy into material products. Combining it with the service and auxiliary operating branches, these production branches will form the nucleus of the developing large regional industrial complexes (Kansk-Achinsk, Sayan, Central Yeniseyi, Surgut, etc).

We consider it necessary to solve this question in due time and by developing the energetics bases of the east, as well as together with the development of the receiving systems of the European region and the Ural and the Central Asian district.

In order to develop the energetics we are preparing the technology of the future in the time period extending to the year 2000, based on the new but already applied technologies.

The next 20 years will be the period when research, engineering-planning, industrial experimentation, demonstration and production work will begin in

broad areas to establish the practically unlimited new energy sources. The vistas of developing the energetics of the 21st century and of transforming chemical energy to electrical energy are connected to this implementation; through them the degree of efficiency of energy usage will be able to be significantly increased. Our joint projects with the United States of America are well known in the areas of the MHD process, solar-energy utilization, etc. In my opinion, the time has arrived to organize similar projects also in the area of thermonuclear energetics goals.

In recent years, the possibility of using hydrogen in energetics generated much attention. Hydrogen's advantages consist of burning without polluting the environment, the energy losses in transporting it in pipelines are smaller than those of electrical energy transmission, and hydromen makes it possible to accumulate (store) energy. However, hydrogen is not a primary energy source, inexpensive technology would be needed to produce it. The electrolysis of water to obtain hydrogen is a very energy-demanding process. This would probably become economical only if we organized the production of hydrogen in the low valleys of the production schedule with the system's nighttime energy outside of peak time periods, which must be developed in the interest of uniform operation of the basic-load power plants (for example, nuclear power plants).

The methods of producing hydrogen are currently also being analyzed, among other things, by using the heat of nuclear reactors. But for the time being the most efficient ones of these schemes cannot be implemented since heat-generating reactors of sufficient temperature do not yet exist.

Those energy technology schemes where, for example, the processes of electrolysis and hydrogen production serve the production of chemical products and at the same time also cover peak loads in energetics also expect to receive some attention.

Evaluating the role of hydrogen from the viewpoint of using it in energetics, those limitations must be taken into consideration in all cases which hydrogen creates as being primarily a raw material in the chemical industry. On the other hand, in case of use only in energetics the value of hydrogen with the present methods is significantly higher than the total costs of fuel.

Thus it can be said that specifying the long-range dimensions of using hydrogen in energetics still requires significant scientific, technological and economic research.

Questions on the development of energetics, supply with primary energy sources, energy frugality, etc, as is well known, were topics of the work of the 10th World Conference on Energy held in Istanbul in September 1977.

The magnitude of development work ahead of us can be characterized by the expected tripling or quadrupling of the world's primary energy demand by the year 2020 (to 34 billion ETA), and a sixfold increase in electrical energy demand.

In numerous industrially advanced capitalist countries, the present and future situation of energetics causes great worry. It can be expected that petroleum will continue to become more expensive; the development rate of nuclear energetics is being reviewed in the direction of decreasing it (by the year 2000 it is expected that the output capacity of the world's nuclear power plants will be 1,300 to 1,500 GW--2 to 2.5 times less than in the prognosis submitted to the Nineth World Conference on Energy held in Detroit in 1974. Coal mining should be increased severalfold, but even the authors of the prognosis themselves are convinced in practical terms that such rates are unrealistic because the mechanism does not exist which would force the companies to volunteer significant, long-range investments in the coal industry, in rebuilding the production apparatus of the consumers, etc.

Very much is being said in numerous countries about frugality with energy. However, the savings program cannot be simplified to statements or possibly to orientation toward the value criteria. The fundamental direction of effecting savings is rational organization of energy production, transformation, transportation and distribution, with systematically involving the long-range development planning of the fuel-energetics complex. In other words, the problem of frugality with fuel and with energy is not an "external" measure but an organic component of developing the fuel-energetics complex and of shaping its optimum structure, which naturally can be defined within the framework of the country's unified, comprehensive economic-development plan.

In solving our energetics problems, the Soviet Union follows this road starting out from the Leninist GOELRO plan [Gosudarstvennaya Komissiya po Elektrifikatsiyi Rossiyi--National Commission for the Electrification of Russia].

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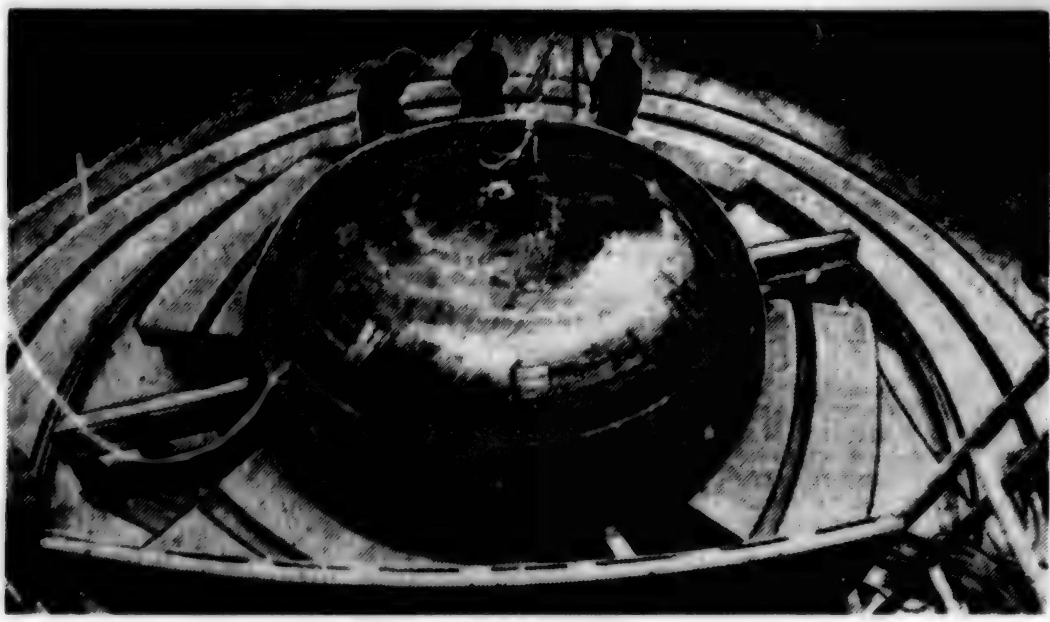
ELECTRIC POWER

PROGRESS REPORT ON VOLGODONSK ATOMMASH PLANT CONSTRUCTION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Jan 80 p 2

[Unattributed news brief: "Atommash Today"]

[Text] Assembly of a horizontal boring machine designed for machining large parts is proceeding precisely on schedule in the reactor vessel equipment shop at the Volgodonsk Atommash Plant. This critical job is being performed by leading assemblers A. Sadikov, F. Agafonov, and B. Kamanchuk. The second photograph shows machining of the bottom of the first reactor.



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ELECTRIC POWER

TALLIN ENERGY SUPPLY FROM TETS-2 'IRU'

Tallin SOVETSKAYA ESTONIYA in Russian 12 Dec 79 p 2

[Article by N. Bergman, inspector, Estonian SSR People's Control Committee: "Cold Attitudes Toward Hot Water and Other Oddities"]

[Text] A complaint was received by the Estonian SSR People's Control Committee. The tenants of Cooperative Building No 52 on Fedyuninskiy Street, located in the new rayon of Lasnamyae and opened for occupancy at the end of 1978, expressed indignation over an exorbitant increase this year in the rate for heat and hot water. Going out to the site and interviewing representatives of both parties to the dispute -- the Makhovykh family and the people at the operations administration of the Lasnamyae housing-construction cooperative, we were able to establish that the rate charged for heating has indeed increased considerably effective the second quarter of 1979.

Comrade Roosar, top official of the organization which collects payments from the tenants and pays the heat supplier -- the Tallin Boiler Plants Board, explained that the rate hike was due entirely to a corresponding increase in heat bills submitted by the Board. He did not know the reason for the increase and had failed to inquire, in spite of numerous citizen complaints.

An inquiry addressed to Comrade Ots, deputy chief of the housing administration of the Tallin City Soviet Executive Committee, also failed to clarify the matter. He assured the Estonian SSR People's Control Committee that all billings between rayon housing operations offices, the public and the Tallin Boiler Plants Board were correct. Officials at the Tallin Boiler Plants Board, which buys electricity from Tallin TETs No 2 "IRU" and supplies it to rayon housing operations administrations, explained that such high bills for heat were due to the high cost of thermal energy produced at the TETs. The reason was that the TETs was new and was operating greatly underloaded.

An investigation showed, however, that the officials of the city housing administration, the housing operations administration of Morskoy Rayon and the building administrations of Lasnamyae had simply taken no interest in

the toiler complaints and had displayed incompetence in matters of heating rates. Even worse are the officials at the Tallin Boiler Plants Board, who added to the bills submitted to the housing operations administrations the cost of replacing heating water losses in the systems.

According to law, the costs of replacing water leakage from the systems should be borne by the organization operating these systems, in this case the Tallin Boiler Plants Board. But as a result of negligence and even ignorance on the part of certain board officials, these costs, which amounted to approximately 6,000 rubles a month for the entire Lasnamyae, had been added all year to the bills of the building administrations, and those in turn had passed them on to the apartment tenants.

From the time of initial occupancy of Lasnamyae housing through October 1979, the new tenants had overpaid 50,513 rubles for heating and hot water. Of course now these overpayments will be made good to the people of Lasnamyae by the various housing organizations through rate reassessment. One is surprised, however at the irresponsibility of these officials, who allowed this violation to go on for an entire year and who failed to respond to toiler complaints.

We should state that the committee's investigation did not end with this. It was necessary to determine the cause of leakage of heating water from the systems, which operate on a closed cycle. What did they find out? On the route between TETs IRU and the boiler plants of Lasnamyae Rayon, building-internal systems lose each month an average of 6,000-8,000 cubic meters of water. And this is chemically treated water for boilers, costing 1 ruble 25 kopecks per cubic meter according to the calculations of TETs IRU.

It was subsequently determined that these losses are not "natural" leakage but are caused by willful use of heating system water for flushing out and pressure testing apartment and building internal heating systems by construction organizations of the Estonian SSR Ministry of Construction. This happened as a consequence of total lack of monitoring of water consumption in apartment internal systems on the part of the Boiler Plant and Heating Systems Board of the Tallin City Soviet Executive Committee.

Energy sales officials of Estonglavenergo also knew about the substantial water losses in the heating system lines, but they did not even lift a finger to correct these problems. In a year's time unwarranted losses of chemically treated heat-transfer water totaled approximately 60,000 cubic meters, and approximately 700 tons of standard fuel was wasted on heating it.

The picture would not be complete if we failed to state that the construction organizations of the Estonian SSR Ministry of Construction and Capital Construction Administration of the Tallin City Soviet Executive Committee are responsible in large measure for what has occurred. After a full year of operation they have still failed to correct numerous

construction defects at the boiler stations and in the apartment internal heating systems of Lasnamyae, and they have not even been transferred over to the balance sheet of operating organizations, the Tallin Boiler Plants Board. This has greatly complicated operation and servicing of Lasnamyae energy facilities, and in particular monitoring of consumption of heating system water.

In November the Estonian SSR People's Control Committee examined the results of the investigation and took appropriate measures to correct the problems. The guilty parties were brought to account.

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ELECTRIC POWER

EKIBASTUZ DC POWER TRANSMISSION LINE PRAISED

Moscow STROITEL'NAYA GAZETA in Russian 23 Jan 80 p 3

[Article by M. Pchelin, head of Glavniiproyekt, USSR Ministry of Power and Electrification: "A River of Energy Will Flow"]

[Text] As we know, every river has its source and mouth. This "river" -- a river of energy -- rises in the northern part of Kazakhstan, at a group of mighty Ekibastuz GRES, which are being built at the site of vast deposits of cheap coal. The mouth of this river is the center of the European part of the USSR, where huge industrial consumers of electric power are located. This river stretches an unprecented distance -- 2,400 kilometers -- delivering energy from Ekibastuz across the Ural Mountains to the Central Region. And this is very important. The fact that the places where energy resources are produced and consumed are dispersed in different regions leads to a rapid increase in flow of fuel from east to west. Scientists have calculated that in 1980 it will be necessary to transport approximately 650 million tons of standard fuel, and substantially larger quantities in subsequent years.

All modes of transport are essential for moving such a vast quantity of fuel and energy. Ultrahigh-voltage direct-current power transmission from Ekibastuz to the Central Region (at 1,500,000 volts) is designed precisely for long-distance transfer of electric power and at the same time for strengthening the link between the Northern Kazakhstan Unified Power System with the Unified Power System of the European part of the Soviet Union. This will be the first extremely long-range direct-current transmission, a unique "window on Europe" for the growing flow of fuel and energy resources.

DC lines are more efficient for long-distance transmission of electricity. In addition, stability and reliability of the unified power systems in emergency situations are increased. Even when one of the line terminals is cut off, the line continues transmitting at 50% power. AC lines lack this capability. In addition, electricity is transmitted on two wires in place of the three used with AC transmission, and this makes it possible substantially to reduce nonferrous metal consumption. Since total weight of the wires is less, the towers on DC transmission lines are also considerably lighter.

Construction of this power transmission line will be carried out in stages, in four sections. construction of the first section of the line has already begun.

Qualitatively new problems were solved in the preliminary design, in particular operation of converting substations in two parallel branches, tandem connection of bridges at each terminal, and study of converting substation operating conditions. Since Ekibastuz power transmission is based on a fundamentally new technical foundation, special development of more than 60 new equipment items was required.

It was designed by organizations and scientific research institutes of the USSR Ministry of Electrical Equipment Industry and Ministry of Power and Electrification: the All-Union Electrical Engineering Institute imeni V. I. Lenin, the Alternating Current Scientific Research Institute, and the Energoset'proyekt Institute.

In contrast to traditional AC power transmission, the terminal substations with their DC equipment are much more complex. And one can well understand why. These are powerful converting devices employing modern semiconductor components, which rectify alternating current into direct current and then invert it back to alternating current. This equipment includes in particular a complex of powerful automatic control devices, which protect the line in case of occurrence of various emergency situations, as well as against excessive voltages. There is also an aggregate of equipment and switching devices which provide line operation in various modes.

All this equipment (the high-power circuit breakers are world firsts) has been designed and developed by Soviet scientists and will be manufactured at Soviet plants. Before receiving approval to manufacture, it must go through a series of tests. A full-scale model, although shortened, of the line has been built near Moscow, operating at full voltage, 1,500 kilovolts, while the converting substation equipment is being tested at Tol'yatti. For example, semiconductor devices which have replaced mercury rectifiers -- which are rather unwieldy and not very operationally reliable -- at converting substations have been subjected to an extensive testing program. I might mention that the first DC transmission lines from Kashira to Moscow and Volgograd to the Donbass were equipped with mercury rectifiers. Semiconductor or, as they are called, thyristor rectifiers are distinguished by a reliable control system and means of protection against service breakdown. This type of equipment is also being employed for the first time anywhere in the world.

As a result of research and design activities, it has become possible substantially to simplify rectifying and inverting circuits and to reduce the quantity of equipment by doubling the power of the thyristor rectifiers and cutting their number in half. This results in a substantial decrease in the cost of substations and in the volume of construction work required.

The designers examined in detail questions connected with construction of a power transmission line and by scientific and design substantiation boosted efficiency to at least 90%, which will ensure fuller utilization of the fuel-energy resources of Ekibastuz and their transmission to the European part of this country. This work has been successfully completed, and at the present time these transmission figures are the best in the world. For example, the cost of electricity at the terminal end of the transmission line will be cheaper than that obtained from GRES in the European part of the country fired by hauled-in coal.

The Ekibastuz line is a step toward the development of even higher-capacity and longer high-voltage lines, essential for utilizing those great quantities of energy which can be conveyed from the Kansk-Achinsk Fuel-Energy Complex. As we know, the latter contains vast fuel reserves. And without question the most important mode of transport which can convey a portion of this energy from KATEK to the European part of the country is electronic. Our institutes are already working on designing higher-voltage power transmission lines -- 2,250 to 2,500 kilovolts. Every year such lines will transmit a flow of energy from KATEK equal to 240 billion kilowatt hours. This is approximately one fifth of the total electricity currently being produced at this country's electric power stations.

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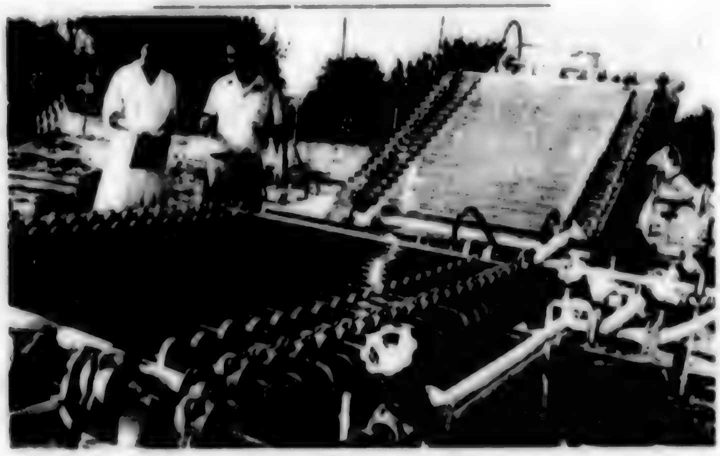
ELECTRIC POWER

PROTEIN-RICH CHLORELLA GROWING EQUIPMENT TESTED

Tallin SOVETSKAYA ESTONIYA in Russian 11 Dec 79 p 1

[Unattributed news brief: "Sun's Energy Working"]

[Text] At the heliobiology laboratory of the Institute of Solar Energy of the Turkmen SSR Academy of Sciences, production testing has been completed on growing chlorella, microscopic aquatic plants rich in protein content. This project is of great practical significance for expanding the livestock feed base in this republic.



In the above photograph Chary Amanov, head of the Heliobiology Laboratory, and Engineer Gyzylgul' Kurbaniyazova test operation of the equipment for growing chlorella.

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ELECTRIC POWER

BRIEFS

NIZHNEKAMSK GES--Naberezhnyye Chelny--The second unit at the Nizhnekamsk GES has been put under load. On New Year's Eve it began feeding electric power into the European Grid. The hydropower construction people installed this generating unit on a compressed timetable. The Nizhnekamsk GES will be the largest hydroelectric power generating facility on this Volga tributary. Its 16 generator units, with a total generating capacity of 1,248,000 kilowatts, will make it possible substantially to improve reliability of power supply to the Kama Truck Plant, the oilfields and other enterprises along the Kama River. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 1 Jan 80 p 2] 3024

MAGADAN POWER LINE--LEP-220 [Power Transmission Line-220] has been successfully tested. Now all central rayons of Magadanskaya Oblast are connected into the power grid. This new 670 kilometer power line will in the near future be transmitting power from the Kolyma GES to mining and beneficiation combines. [Text] [Moscow STROITEL'NAYA GAZETA in Russian 1 Feb 80 p 2] 3024

BURYAT ASSR GRES--The USSR Ministry of Power and Electrification has looked into critical comments on deficiencies in organizing work at the construction site of the Gusinoozersk GRES, contained in a news report entitled "Bypassing Acute Problems" (SOTSIALISTICHESKAYA INDUSTRIYA, 30 Oct 1979). The newspaper correctly noted work deficiencies and the reasons for delay in construction of the Gusinoozersk GRES. Questions pertaining to improving organization of labor and accomplishing the tasks assigned the construction project work force were discussed directly at the construction site by officials of the USSR Ministry of Power and Electrification, with the participation of officials from the Buryat ASSR CPSU Committee. As a result of measures adopted, at the end of last year the fourth 200,000 kilowatt generating unit was brought on-stream. In order to speed the pace of housing construction, an additional 300 finishing operation workers were assigned to housing construction, and the requisite material-technical resources were allocated. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 Jan 80 p 2] 3024

NUCLEAR POWER TURBINES--Khar'kov (TASS)--The Khar'kov power machinery builders have reached an important landmark on their Lenin shock work shift. Static testing has been successfully completed at the Plant imeni Kirov on the first of two 500,000 kilowatt nuclear power generator turbines for the final generating unit at the Leningrad Nuclear Power Station. They have started shipping the machinery. When the second of these units is installed, the generating capacity of this flagship of the Soviet nuclear power industry will be raised to 4 million kilowatts, as targeted by the 25th CPSU Congress. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 3, Jan 80 p 5] 3024

STAVROPOL' GRES--Solnechnodol'sk--The sixth generator unit at the Stavropol' GRES has been placed under commercial load. The generating capacity of this power station is now 1,800,000 kilowatts. An advanced large-module method of installation as well as other innovations were widely employed on this construction job. A chimney stack with stack interior of silicon-concrete panels has come on-stream. According to calculations by specialists, its service life will increase severalfold. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 Jan 80 p 2] 3024

CENTRIFUGAL-CAST STEEL PIPE--Dnepropetrovsk--The Nikopol' Yuzhnotrubnyy Plant has started up production on large-diameter centrifugal-cast steel pipe. This pipe is intended for use at large thermal electric power plants and is designed for an extended service life. A test batch of new pipe, the manufacturing process for which was developed by scientists in Dnepropetrovsk, was tested at the Kashira and Slavyansk GRES. [Text] [Moscow IZVESTIYA in Russian 22 Jan 80 p 1] 3024

PECHORA GRES--Komi ASSR (TASS)--The second generator unit at the Pechora GRES has been placed under commercial load. This station is the power engineering heart of the Timan-Pechora Production Complex which is being established in the Komi ASSR. Electric power generated at this plant will be used in mining coal and conveying crude oil and gas great distances, in cooking wood pulp and manufacturing paper. Power will also be supplied to neighboring Arkhangel'skaya and Kirovskaya oblasts. The new power station is an example of comprehensive exploitation of the natural resources of the Arctic. All its generator units will be fired by casinghead gas from the Usinskoye and Vozeyskoye oilfields, which previously had been flared off. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 16 Jan 80 p 1] 3024

PROKOP'YEVSK ELEKTROMASHINA PLANT--The Ministry of Electrical Equipment Industry, having looked into the article "Partner's Footboard," which appeared in the 28 September 1979 issue of this newspaper, reports that the critical comments contained in the article about unsatisfactory delivery of machinery by the Prokop'yevsk Elektromashina Plant and electric motors by the Riga Electrical Equipment Plant are acknowledged to be correct. The problems raised in the article have now been resolved. The Ministry of Electrical Equipment Industry has assisted the Elektromashina Plant in obtaining steel castings from other enterprises of this branch, and foundryman-specialists and workers of other specializations have been sent to

the plant. DC machinery is now being delivered on schedule. Delivery operations are being closely monitored. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 28 Dec 79 p 2] 3024

LATVIAN POWER CONSTRUCTION--Every day new machine tools and new equipment come on-stream at dozens of enterprises in this republic, making people's work easier. This means that electric power requirements are increasing day by day. Latvia's power industry construction people clearly understand this fact. They did a fine job in the 10th Five-Year Plan strengthening the power industry base. Finishing operations proceeded in full swing at the Riga GES, and much labor was invested in renovation of the Kegums GES, pioneer Latvian power industry facility. The third turbine installed here in the course of renovation went into operation of the eve of the 62d anniversary of the Great October Socialist Revolution. A bit later, at the end of last year, another signal lamp lit up on the board in the control room at the Northwestern USSR Power Systems Control Center, indicating that a fourth turbine unit had fired up at Riga TETs-2. Renovation and expansion of GES and TETs as well as skilled utilization of equipment made it possible to increase generating capacity by more than 500,000 kilowatts in a period of 4 years. Additional growth in this republic's power potential is anticipated in the near future. At the end of last year construction on the fourth GES on the Daugava began near Daugavpils. This facility will make it possible to utilize the energy and water resources of the Daugava more efficiently. [Text] [Riga SOVETSKAYA LATVIYA in Russian 30 Jan 80 p 2] 3024

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ORENBURG GAS COMPLEX REVIEWED

Moscow EKONOMICHESKAYA GAZETA in Russian No 6, Feb 80 p 1

[Article: "The Orenburg Complex"]

[Text] "Build a large industrial complex for the extraction and refining of gas based on the Orenburg gas condensate deposit." This was the challenge laid down by the 25th CPSU Congress in the document "Basic Directions of Development of the USSR National Economy for 1976-1980." This challenge has been met. In the fourth year of the five-year plan the complex exceeded its projected capacity.

The following comparison gives some idea of the scale of the new industrial giant. In 1960 all the gas fields of the Soviet Union produced 45 billion cubic meters of natural gas. Today the Orenburg industrial complex alone produces slightly more than that each year. Trunk gas pipelines have been laid from the complex to the central regions of the country, the Volga region and the Bashkir ASSR. The Soyuz underground pipeline, built with participation of the members of the Council of Economic Mutual Assistance, which went into operation last year, will transport 15.5 billion cubic meters of Orenburg gas to the fraternal socialist countries each year. The extraction of natural gas in the USSR (in billions of cubic meters) was 289 in 1975, 321 in 1976, 346 in 1977, 372 in 1978, 407 in 1979, and 435 according to the 1980 plan.

A distinctive feature of the Orenburg deposit is that the gas contains a significant amount of condensate and other valuable components. Difficult scientific-technical problems of field extraction and factory refining of gas, designing special equipment, and protecting the environment were resolved during the planning and development of the industrial complex.

There are many structures among the facilities built in the steppe in this short time. The refinery has no equal in our country for capacity. It includes the most up-to-date units to remove hydrogen sulfide from

gas and produce sulfur and liquefied gases. The first phase of a plant producing helium and ethane has been built. Among the products in addition to natural gas and sulfur are stable condensate and a broad range of light hydrocarbons used as raw material in industry.

Along with industrial facilities, a total of 450,000 square meters of housing space, nursery schools and daycare centers for 2,550 children, schools for 6,000, a hospital, stores, and other cultural-domestic facilities have been built during the current five-year plan for the gas workers.

The collective of the complex has become one of the leaders in the gas industry. The Orenburggazprom [Orenburg Gas Industry] Association met its plan for the first four years of the five-year plan ahead of schedule, on 5 October 1979. Senior shift engineer G. Volkov and gas turbine machine operators S. Agapov, D. Bukin, V. Astashov, and P. Kolokolov (shown from left to right in photograph [not reproduced]) are setting examples of shock work in socialist competition.

The employees of the complex have promised to extract and refine 800 million cubic meters of gas beyond their assignment by the 110th anniversary of the birth of V. I. Lenin and to produce 47.3 billion cubic meters for the entire year, 2.3 billion beyond the plan.

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NEW AUTONOMOUS OFFSHORE DRILLING RIGS READY FOR WORK

Moscow IZVESTIYA in Russian 23 Jan 80 p 6

[Article by A. Polyakov: "Distant Voyages of the Drilling Rig"]

[Text] Specialists at the USSR Ministry of Shipbuilding Industry are designing a series of offshore drilling rigs to drill extremely deep oil and gas prospect wells, down to six kilometers in as much as 200 meters of water. The first rig has already been assembled and sent to the operation region.

The helicopter was flying above the sea. It slowed down, descended, and softly landed on a small platform, marked like a target, hanging above the waves. Out of the vehicle came people dressed like sailors.

"In fact, work on the new drilling rigs will greatly resemble a sea cruise," said V. Potapov, chief project designer. "Remoteness from shore, tours of duty, identical clothing, and a strict schedule. Whereas the old rigs such as the Sivash were towed over the water to the field and then secured to the bottom with steel 'legs' before the drills began chewing into the shelf, this rig is always floating. So you see, here you have to be both a driller and a sailor. This is taken into account in the training the crews."

As for the equipment itself, the first thing I want to observe is that it did not appear by chance. There is a target program for geological development of the shelf, and corresponding to it another program has been developed to build the machinery needed for this. So here we have the floating factory designed to sink exploratory and prospect wells in the sea floor. The rig has a modern drilling unit with a derrick more than 50 meters high, powerful drilling pumps, equipment to cement up the wells, and more. The fact that the rig is actually floating makes it possible to reach greater ocean depths.

But this also has its problems, for example oscillations, even though they are minimized by special design features. Special compensators for

movement of the drilling stems soften the blows of the waves and prevent them from endangering the drilling mechanisms. The steel platform is maintained on the water by two large pontoons, and it is held at the drilling point by eight 18-ton anchors whose electrically welded chains are made of high-strength steel.

A system for monitoring the position of the drilling rig during operations has been employed for the first time. It records the slightest deviation, which means it can be corrected quickly. The instruments and pickups will constantly monitor the drilling process. The diving complex is also well-equipped, for many problems are possible underwater. Communications with shore have been worked out. After the day's work convenient single and double cabins await the workers. The floating rig can operate for 30 days with its own fuel supply. Several shipyards are taking part in building the series of new rigs.

New equipment is to begin operations soon, but specialists are undertaking another project, a drilling ship with dynamic stabilization. A system of screw propellers that is turned off and on automatically depending on wave direction, current, and wind will make it possible to hold the ship in the necessary position.

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FUELS

ACHIEVEMENTS OF 'CHERVONA ZIRKA' MINE

Moscow IZVESTIYA in Russian 25 Jan 80 p 2

[Article by N. Lisovenko, Donetskaya Oblast: "A Mine Record"]

[Text] The mine workers of the "Chervona Zirka" mine of the Torezantratsit [Torez Anthracite] Association of the Donets Basin were the first in the USSR coal industry to complete the plan of the 10th Five-Year Plan.

The miners sent up 2,504 tons of coal, including 650 tons beyond the plan, on this remarkable day. Before the end of the year they will extract an additional 580,000 tons of anthracite.

And yet, not long ago, specialists were arguing about whether the time had come to shut down the mine. In its 60 years of operations all the rich seams had been worked out. It is true that there were still a few "balance" reserves where the thickness of the seams was seldom greater than half a meter. Would the difficulties of extracting coal from such seams be worth it?

"It must be worthwhile," the miners said. The full arsenal of equipment for working thin seams, planers, cutters, and various combines, was used for the job. The mine which, not long before, was under consideration for closing down began to produce 550,000-570,000 tons of anthracite a year.

At the start of the 10th Five-Year Plan some economists felt that the plan, 1,800 tons of coal a day, was too much for the collective of this old mine, but the miners wanted no concessions. Day after day, quarter after quarter, and year after year every section and each one of the 18 extraction brigades fulfilled its production program.

Only the miners can assess the significance of these figures: the average daily extraction from a wall 0.55 meters thick ranged between 420

and 540 tons. During the 10th Five-Year Plan they sent up 2,425,000 tons of anthracite. Moreover, the prime cost of each ton was 15 kopecks lower than planned. The labor productivity of the miners rose 813 percent in this time, which was double the planned figure.

The names of those made the greatest contributions to fulfillment of the five-year plan are now spoken with respect: the collective of the fourth section headed by V. Sadovskiy, Aleksandr Kasenkov's brigade, which was the first in the association to complete its five-year plan assignment, Dmitriy Khomich's drillers, who drilled 17.7 kilometers of underground passages in the last four years, combine operator Ivan Vedyashkin, who cut 74,000 tons of anthracite, and section mechanic Petr Yavtukhovskiy, who made 30 efficiency proposals, as well as many, many other people.

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CHERVONOGRAD COAL CONCENTRATING COMPLEX BEGINS OPERATIONS

Moscow IZVESTIYA in Russian 31 Jan 80 p 1

[Article by A. Matveyev, Chervonograd, L'vovskaya Oblast: "The Giant Is on Line"]

[Text] The largest coal concentrating plant in the USSR has been turned over for operation to the Ukrzapadugol' [Ukrainian Western Coal] Production Association. It will produce 9.6 million tons of high-grade concentrate a year, which is 32,000 tons a day!

"Launching such a complex," says M. Ikonnikov, member of the Board of Directors of the USSR Ministry of Industrial Construction, "is a major event for both construction workers and coal miners. There is no other complex in our country, nor in Europe, that is the equal of this one in the design concepts of the buildings and structures or in operating characteristics. Before this enterprise was launched the biggest concentrating factory in the Donets Basin processed 4.5 million tons of concentrate a year. The Chervonograd giant will concentrate coal from all 12 mines of the L'vov-Volyn Basin. Its output is designated for the power plants of the Mir Energy System."

The structures of the complex soar dozens of meters into the sky. There are 89 large installations. They are arranged compactly, in 80 hectares. Credit for this goes to specialists at the Yuzhgiproshakht [State Institute for the Planning of Mines in the Southern Regions of the USSR] and UkrNIIugleobogshcheniye [Ukrainian Scientific Research Institute of Coal Concentrating] Institutes.

The enterprise has received highly productive equipment. All processes from receiving the bulk rock to shipping finished products are fully mechanized. The Chervonograd concentrators can ship up to 4,500 tons of concentrate an hour, enough to fill a 72-car train!

The ash content of coal mined in the L'vov-Volyn Basin exceeds 34 percent. It is not easy to concentrate. But despite technological difficulties,

the concentrate produced here will be very cheap. The prime cost to concentrate a ton of standard coal is just 89 kopecks. New concentration technology will make it possible to use coal which formerly was considered unprofitable to mine.

Great attention has been given to environmental protection. The complex has a self-contained water supply system and effective means of decontaminating waste.

The general contracting collective of the Ukrosobuglemontazh [Ukrainian Special Coal Equipment Installation] Trust of the Ukrainian Ministry of Industrial Construction has done a good job. It was not easy work. The hydrogeological conditions were difficult. At first the plan called for freezing the ground. But it proved possible to handle underground flows by lowering the water table. As a result, the coal reception unit was turned over almost a year ahead of time. Full-sized 20-meter piles with prestressed reinforcement were used to lay the base for the foundation of the bunkers. Here too they gained time and saved metal.

V. Stysin, chief of the start-up complex, names the best workers at the construction site: M. Vashchuk, M. Koval'chuk, Ya. Mel'nikovich, and I. Farat. These are the leaders of a collective of more than 2,000 construction workers. At this important national economic project 40 million dollars worth of construction and installation work was done. The machinery of the enormous system has now been turned on. The Chervonograd giant has begun its work under the five-year plan.

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UNDERGROUND GASIFICATION OF COAL

Kiev RABOCHAYA GAZETA in Russian 7 Feb 80 p 2

[Article: "When Coal Is Burned Underground"]

[Text] Underground coal gasification is being modeled at the Institute of the Geology and Geochemistry of Useful Minerals of the Academy of Sciences Ukrainian SSR in L'vov. Doctor of geological and mineralogical sciences V. A. Kushniruk, head of the division of coal geology, spoke with an APK correspondent about the purpose and importance of this experiment.

"The underground reserves of the L'vov-Volyn coal basin hold more than 3 billion tons of coal. Only one-third of it can be mined by the underground shaft method. Miners today are working only six layers of the 88 that have been explored. Two more layers will be brought into operation in the coming years. The remaining ones are quite thin and it is unprofitable to mine them by shafts. However, the coal of these thin horizons, which comprises more than three-quarters of all the reserves of the basin, is good-quality coal.

"In connection with this our institute is modeling underground coal gasification. Our scientists want to determine the optimal conditions for introducing, in the L'vov-Volyn Basin, this generally recognized method of exploiting such coal layer."

"In our country," V. A. Kushniruk continued, "we already have three such industrial stations for underground gasification of brown and hard coal. They are in operation in the suburban Moscow Basin, the Kuznets Basin, and in Central Asia. The coal is converted to combustible gases and uses as energy fuel or chemical raw material for obtaining a whole series of valuable products such as high-grade liquid fuel. The production personnel and resources that are liberated are used to build coal chemical enterprises."

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